Monte Carlo Simulation of C-Band Backscatter fro Saline Ice Covered with Frost Flowers

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Abstract

Frost flowers are saline ice crystals growing on the surface of young sea ice. The flowers are accompanied by slush patches underneath the ice crystals. Frost flowers have become interested in the study of sea ice remote sensing owing to their role in the observed enhancement of radar backscatter from thin sea ice. An experiment was carried out, at the Geophysical Research Facility in the Cold Regions Research and Engineering Laboratory in 1995, to investigate the effects of frost flowers on the C-band polarimetric radar response from saline ice. The observed backscattering coefficients showed an increasing trend with the coverage of frost flowers on ice. However, a backscatter minimum occurred in the early stage of frost flower growth which coincided with an abrupt change in the saline ice surface salinity.

In this work, we develop an electromagnetic backscattering model of thin saline ice covered with frost flowers. The formation process of frost flowers during the growth of ice is simulated using a random walk model. The geometric parameters, like the coverage and dimension, and the physical parameters like the salinity and temperature, of the frost flower slush patches are incorporated into different simulated stages in accordance with the measured characterization data. Backscattered field is then calculated from the simulated scenario by solving a volume integral equation based on an approximated internal field. The induced internal field within the slush layer is approximated by adopting a layered-medium model which takes into account the salinity profile of saline ice. The backscattering coefficients are obtained by averaging over many simulated realizations. This Monte Carlo scattering model is applied to interpret the observed temporal variation of the polarimetric signatures.